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SYNTHESIS OF DESIGN AND EVALUATION PROCEDURE OF ELECTRIC VEHICLE BATTERY MODULE WITH SIMPLIFIED FINITE ELEMENT MODEL

Pranati Pradnya Pradyot Kedar[1]

[1]*P.G. Research Scholar, Mechanical Engineering, Priyadarshini College of Engineering Nagpur*

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Abstract - Researchers turn to electric automobile (batteries), primary power storage system in the United States of America, with theories as a solution to the environmental problem of increased pollution from the use of conventional power sources (nonrenewable energy) due to the transition to electric mobility are gathering. Efficient peak and average power make batteries the best choice for energy depository. Lithium-ion chemistry has proven to be an systematic battery technique in terms of power density, specific power, safety, durability and reduced emissions. Requirements for optimum operation include a temperature range of 15°C to 35°C and a uniform temperature profile. This affects vehicle performance and is a cause for concern. This highlights the importance of designing an effective battery thermal management system (BTMS). The BTMS is responsible for maintaining a constant temperature range throughout battery operation, improving its lifespan and efficiency. Different BTMS designs have been presented based on different media types, power consumption and thermal cycles. The purpose of this study is to use computational fluid dynamics to analyze different BTMS according to different arrangements of cells in battery modules, and use the results of that analysis to improve the execution of battery modules. It is to propose the most suitable BTMS with high cost efficiency and low maintenance of battery module. This CFD analysis is performed to evaluate airflow using ANSYS Fluent from BTMS. Analyzing the airflow through the battery module provides better insight into changes in cell packing arrangement and changes in the location of active or passive thermal management systems.

***Key Words*:** electric mobility, fossil fuels, reduced emissions, battery technology, battery thermal management system

1.INTRODUCTION

Increasing pollution levels, climate dissimilarity and climate change are the critical problems which have make the necessity of alternate energy source utilization immediate. The evolution to electric vehicles is the current focus as far as the automotive industry's contribution is concerned. Batteries are the most realistic amongst the various alternative energy storage systems, owing to their efficient peak and average power delivery rates.

With the transition to electric mobility, the most main energy depository system for electric mobility has attracted the attention of researchers. This is because it is proposed as a solution to the environmental problem of increased pollution from the use of conventional energy sources (fossil fuels) in electric vehicles. , that is, the battery. Efficient peak and average power make batteries the best choice for energy storage. Lithium-ion chemistry has proven to be systematic battery technology in terms of energy density, specific power, safety, durability and reduced emissions. Requirements for optimal operation include a temperature range of -8°C, 23°C, 52°C and a uniform temperature profile, which is a concern for vehicle accomplishment. This highlights the importance of designing an effective battery thermal management system (BTMS).

The BTMS is accountable for maintaining a constant temperature range throughout battery operation; boost its life and productivity. Various his BTMS designs are granted based on different media types, power consumption and thermal cycles. Battery well-being has several aspects that can further reduce battery life and execution, including: B. Sub-optimal execution due to slowing of chemical reactions during battery operation at low temperatures, ambient temperature causing the battery to exceed temperature limits associated with loss of capacity, electrical imbalance and/or self-discharge.

The purpose of this study is to use CFD to analyze different BTMS for different arrangements of cells in a battery module and use the analysis results to find a cost-effective way to improve the performance of battery modules, to propose an optimal BTMS that does not require maintenance. A CFD analysis of a battery module using ANSYS Fluent is performed using different cell placements for Case 1, Case 2, Case 3, and Case 4.

2. DESIGN OF BATTERIES

Physical model is built by using CAD software. Different 4 cases are taken which includes 16 battery cells inside the battery packs which are arranged at different positions in different cases. In case1, the battery cells are arranged in 2X8 rectangular battery pack. In case1, the battery cells are arranged in 2X8 rectangular battery pack, but the cells are arranged in small distance from each other as compared to case1. In Case 3, the cells are arranged in random arrangement. In Case 4, the cells are arranged in hexagonal random arrangement.

3. MESH GENERATION

The meshing of the battery cells and battery pack is done on Hypermesh and Ansys software. Surface mesh is done on hypermesh and volume mesh is done on Ansys software.

For CFD, a simple mesh of a triangular (tria) element is sufficient since the main objective is to simply capture the geometry. Triangular elements are preferred over quadrilateral (quad) elements since they have greater mesh flexibility to mesh irregular geometries, smoother mesh transitions, reduced computational cost, and reduced grid distortion.

In volume mesh, the first step is the choice of the type of volume mesh. The most common type of volume mesh used for external aerodynamics is the hexahedral or polyhedral meshes because of their superior geometrical accuracy, and high aspect ratio elements which lead to high numerical accuracy and convergence, and better mesh quality.

4. BOUNDARY CONDITIONS

Fluid dynamics boundary conditions are boundary conditions for boundary value problems in computational fluid dynamics. These boundary conditions include inlet boundary conditions, outlet boundary conditions, wall boundary conditions, and temperature boundary conditions.

5. RESULT AND DISCUSSION

CFD analysis of battery module using ANSYS Fluent is performed by taking different arrangement of cells inside case1, case2, case3, case4.
The inlet air temperature and velocity are varied for these arrangements.
The inlet air velocity is taken as 2 m/s and 6 m/s.
The inlet air temperature is considered at -8°C, 23°C and 52°C.
Maximum and average temperature of the battery module is analyzed to identify the optimum cooling arrangement when the air inlet is present on the side of the battery module.

6. CONCLUSIONS

The CFD analysis of battery model has been conducted to analyze and advance the design of the battery thermal management system. A battery module comprising of 16 cells is arranged in different arrangements as case1, case2, case3 and case4.The influence of each arrangement on the average and maximum temperature of battery unit are observed for dissimilar heat-sink arrangements. Moreover, the effect of varying intake air velocity and intake air temperature is also examined. However, on increasing the intaket air velocity and reducing the intake temperature, a remarkable reduce in the temperature is observed for dissimilar arrangement. The fulfillment of the case2 battery arrangement is the most satisfactory arrangement in terms of low battery module temperature, better temperature uniformity of both the battery module and along the cell. It is observed how simply optimizing the actively air-cooled battery thermal management system can satisfy the design requirements from thermal point of view, overcoming the additional weight, cost and threat of leakage which is predominant in other thermal handling systems

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